

Ticks: the foulest and nastiest creatures that be. Pliny the Elder, 23-79 A.D.

Ticks of the Northeastern United States

Ticks are not insects, but are arthropods more closely related to mites, spiders, scorpions, and daddy-long-legs. There are about 80 species of ticks in the United States (850 species worldwide). However, only about 12 or so in the U.S. are of major public health or veterinary concerns with a few others that occasionally attack humans. The ticks discussed in this handbook belong to the family Ixodidae or hard ticks. The principal hard ticks recovered from humans in the mid-Atlantic and northeastern United States are the blacklegged (i.e., deer) tick, *Ixodes scapularis*, the American dog tick, *Dermacentor variabilis*, and the lone star tick, *Amblyomma americanum*. Other tick species recorded as feeding on humans in the eastern U.S. include *Ixodes cookei*, *Ixodes dentatus*, and the brown dog tick, *Rhipicephalus sanguineus*. The Argasidae or soft ticks form the other major group of ticks. Soft ticks are generally nest inhabitants that are associated with rodents, birds, or bats. Several species of soft ticks attack humans and can transmit disease, mainly in western states, but are not the focus of this handbook. One species, *Carios (Ornithodoros) kelleyi*, a bat tick, has been recovered from states in the northeast to at least Connecticut.

Table 1. Important ticks of the northeastern states and some other major ticks of medical importance in the United States.

Tick	Common name	General distribution
Hard Ticks		
<i>Ixodes scapularis</i>	Blacklegged tick	Northeastern & mid-western United States
<i>Ixodes pacificus</i>	Western blacklegged tick	Pacific coast & parts Nevada, Arizona, Utah
<i>Ixodes cookei</i>	A woodchuck tick	Eastern United States & northeast Canada
<i>Ixodes dentatus</i>	A rabbit tick	Eastern United States
<i>Amblyomma americanum</i>	Lone star tick	Southeastern U.S., Texas to New York
<i>Dermacentor variabilis</i>	American dog tick	Eastern U.S. & west coast
<i>Dermacentor andersoni</i>	Rocky Mountain wood tick	Rocky Mountain states south to NM & AZ
<i>Dermacentor albipictus</i>	Winter tick	Canada, United States south to Central America
<i>Rhipicephalus sanguineus</i>	Brown dog tick	All U.S. and worldwide
Soft Ticks		
<i>Ornithodoros</i> species ticks	Relapsing fever ticks	Western United States
<i>Carios kelleyi</i>	A bat tick	Widespread in U.S., north to New York and Connecticut

Scientific Names and a Few Terms

The scientific name of ticks, like other organisms, is given in two parts: genus (capitalized, often abbreviated by the first letter, e.g. *I. scapularis*) and species (not capitalized) sometimes followed by the name of the person who described the organism (given in parenthesis if the genus name is later changed). The name Linnaeus is abbreviated L. Common names like deer tick can vary regionally and some organisms may have no common name. The common names used in this guide follow those officially recognized by scientific societies. Several terms are used to define the cycles of animal, tick and pathogen.

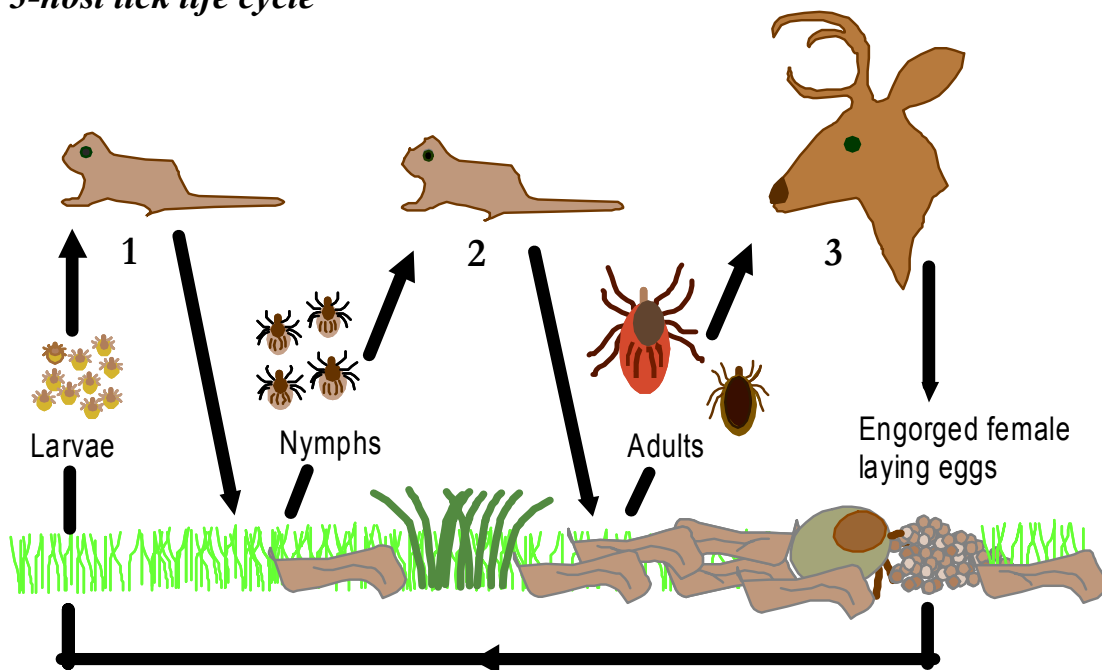
- Pathogen: the microorganism (i.e., virus, bacteria, rickettsia, protozoa, fungus) that may cause disease.

- **Parasite:** An animal that lives in or on a host for at least part of their life and benefits from the association at the expense of the host (from the Greek, literally para - beside and sitos - food).
- **Vector:** An insect or other arthropod, like a tick, that carries and transmits a disease pathogen. Diseases associated with pathogens transmitted by a vector are called vector-borne diseases.
- **Host:** An animal infected by a pathogen or infested with a parasite.
- **Reservoir:** An animal host that is capable of maintaining a pathogen and serving as a source of infection.
- **Zoonoses:** A disease caused by a pathogen that is maintained in vertebrate animals that can be transmitted naturally to humans or domestic animals by a vector or through other means (e.g. saliva, feces).
- **Endemic disease:** A disease that is established and present more or less continuously in a community.

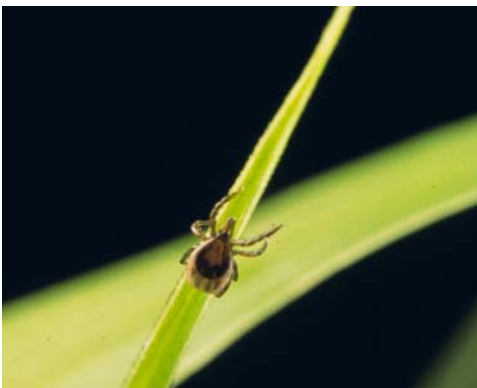
Tick Biology and Behavior

Ticks are essentially mites that have become obligate blood-feeders, requiring a host animal for food and development. Ticks have four stages in their life cycle: egg, the 6-legged larva (seed ticks), and 8-legged nymph and adult (male or female). Larvae and nymphs change to the next stage after digesting a blood meal by molting or shedding the cuticle. Most of the ticks mentioned in this handbook have a 3-host life cycle, whereas each of the three active stages feed on a different individual host animal, taking a single blood meal. Larvae feed to repletion on one animal, drop to the ground and molt to a nymph. The nymphs must find and attach to another animal, engorge, drop to ground and molt to an adult. The adult tick feeds on a third animal. A replete or engorged (blood filled) female tick produces a single large batch of eggs and dies. Depending upon the species of tick, egg mass deposited can range roughly from 1,000 to 18,000 eggs.

3-host tick life cycle



The larvae and nymphs generally feed on small to medium-sized hosts, while adult ticks feed on larger animals. Some ticks may have a one-host (all stages staying and feeding on only one animal host before the female drops off) or other multi-host lifecycles. Depending upon the tick, the life cycle may be completed in 1, 2 or even 3 years, while a one-host tick may have more than one generation per year. Feeding for only a few days, the majority of the life of a tick is spent off the host in the environment either seeking a host, molting or simply passing through an inhospitable season (e.g., hot summers or cold winters). Soft ticks have a multi-host life cycle with multiple nymphal stages; each stage feeds briefly, and adults take multiple small blood meals, laying small egg batches after each feeding. As nest and cave dwellers, often with transient hosts, some argasid ticks may survive many years without a host. However, most hard ticks do not successfully find a host and perish within months or a year or two at best.



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Larval ticks will be clustered on the egg mass after hatching and when ready to feed, ascend blades of grass or similar vegetation to await a host. Ticks assume a questing position by clinging to the leaf litter or vegetation with the back legs, and hold the first pair outstretched. Due to differences in susceptibility to desiccation and host preference, immature ticks generally remain in the low vegetation, while adult ticks may seek a host at a higher level in the vegetation. Ticks detect their hosts through several host odors (including carbon dioxide, ammonia, lactic acid, and other specific body odors), body heat, moisture, vibrations, and for some, visual cues like a shadow. When approached by a potential host, a tick becomes excited - waving the front legs in order to grab the passing host. Ticks cannot fly or jump; they must make direct contact with a host. Once on a host a tick may attach quickly or wander over the host for some time. Some ticks attach only or principally on certain areas like the ear or thin-skinned areas, while other species may attach almost anywhere on the host. Ticks feed slowly, remaining on the host for several to many days, until engorged with blood (see section on feeding in tick bite prevention). Male ticks feed intermittently, take small blood meals, and may remain on a host for weeks. For most ticks mating occurs on the host, as the male tick also requires a blood meal. However, male *Ixodes* ticks do not need to feed prior to mating and mating may occur on or off the host.

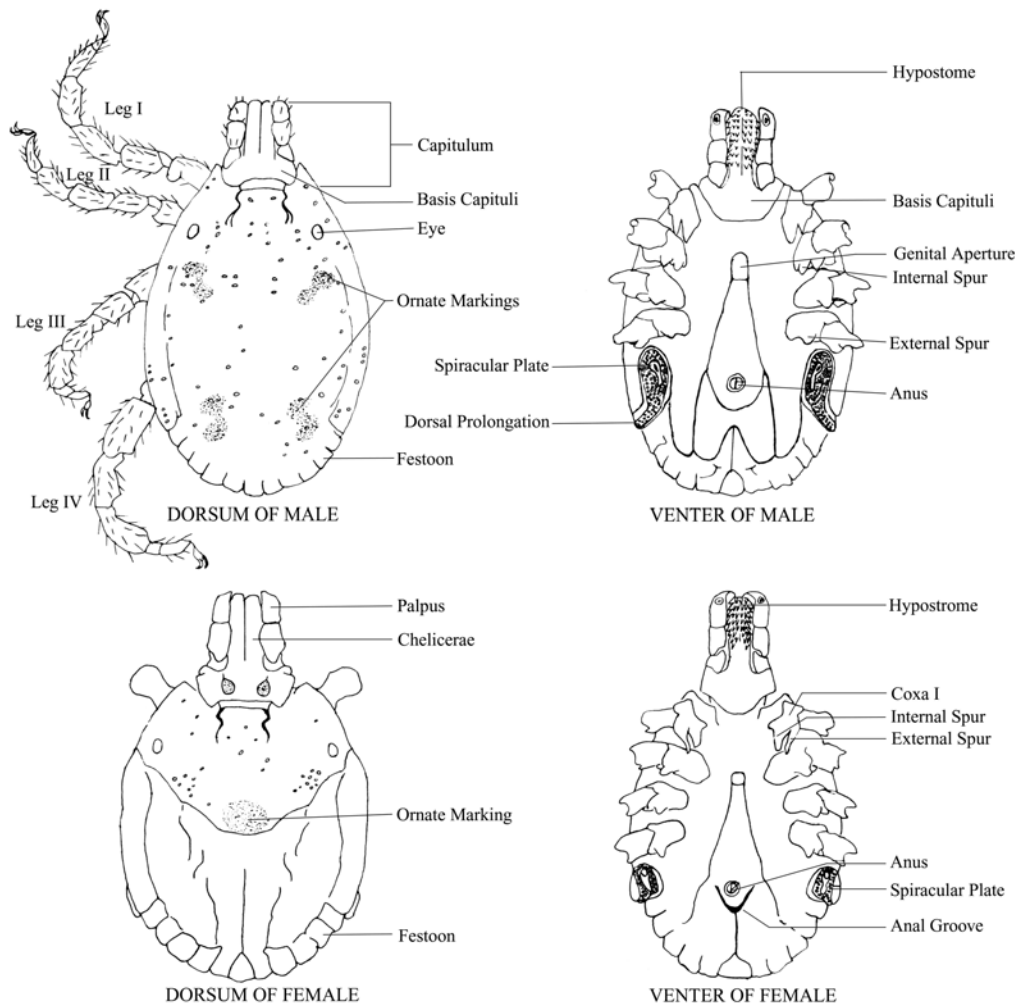


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Tick Morphology

The body of a tick consists of a “false head” (the capitulum) and a thorax and abdomen fused into a single oval, flattened body. A larval tick has six legs, while nymphs and adults have eight legs present. The basal segment of the leg, the coxa, may have spurs that help in identification. An adult tick will have a genital aperture on the ventral surface, located roughly between the second pair of legs. The respiratory system is evident by spiracular plates located ventrolaterally behind the fourth pair of legs in the nymphs and adults. These plates may be oval, rounded, or comma-shaped. Hard ticks get their name from a tough dorsal shield or plate called the scutum present on all mobile stages of the tick. The scutum on the larva, nymph, and female tick covers the dorsal anterior third to half of the body. By contrast, the scutum on a male tick covers almost the entire dorsal surface and expansion during feeding is very limited. The scutum differs in shape and others characteristics (i.e., presence or absence of simple eyes) between tick genera. In some ticks, ornate or patterned markings may be present that can aid in identification. A distinct semicircular anal groove curves around the front of the anal opening in *Ixodes* ticks. In all other ticks, the anal groove is behind the anus or absent. Many ticks, but not *Ixodes*, have rectangular areas separated by grooves on the posterior margin of the tick body called festoons. Festoons, if present, may not be visible on fully engorged females. Argasid ticks are leathery, wrinkled and grayish in appearance. The capitulum of soft ticks is located on the underside of the body and cannot be seen from above.

Hypothetical Male and Female Ixodidae (Hard Ticks) with Key Characteristics Labeled



The capitulum in hard ticks is visible dorsally in all stages. The capitulum holds the mouthparts consisting of a base (basis capituli), two palps, paired chelicerae, and the median ventral hypostome, which is covered with denticles or recurved teeth. The shape of the basis capituli, length of the palps, number of denticles, and other characteristics of the mouthparts are used to help identify tick genera and species.

While the adults of some common ticks can be easily identified with a little training because of distinctive markings or color, the identification of most ticks and the immature stages requires the services of a trained entomologist and the use of keys developed by tick taxonomists. These keys are designed to specifically identify adults, nymphs or larvae.



The Blacklegged Tick or “Deer” Tick, *Ixodes scapularis* Say

Blacklegged tick is the correct common name for the tick popularly known as the “deer” tick (the terms are not used together, it is not called the blacklegged deer tick).

Ixodes (pronounced ix-zod-ease) *scapularis* transmits the causal agents of three diseases; Lyme disease, human babesiosis, and human anaplasmosis. The blacklegged tick is found from some southern portions of Canada and coastal Maine through the mid-Atlantic states into Maryland, Delaware and northern parts of Virginia and in several north central states, particularly Wisconsin and Minnesota, extending down through Illinois and into Indiana. This tick is also found throughout the southeastern United States west to southcentral Texas, Oklahoma, southern Missouri, and eastern Kansas. However, few *I. scapularis* in the southeast have been found infected with the bacterium that causes Lyme disease, the spirochete *Borrelia burgdorferi*. Therefore, the risk for Lyme disease from this tick in the southeastern United States is considered relatively low.

Unfed female *I. scapularis* have a reddish body and a dark brown dorsal scutum (plate) located behind the mouthparts. Length of the female tick from the tip of the palpi to the end of the body is about 3 to 3.7 mm (about 1/10 of an inch). Male *I. scapularis* are smaller (2 – 2.7 mm) than the female and are completely dark brown. Nymphs are 1.3 to 1.7 mm in length, while larvae are only 0.7 to 0.8 mm. Female blacklegged ticks become fairly large when engorged with blood and, consequently, are sometimes confused with engorged female American dog ticks.



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Above: left to right: larva, nymph, male and female *I. scapularis*. Below top: unfed and engorged female. Below bottom: male, female and engorged female with straight pin.

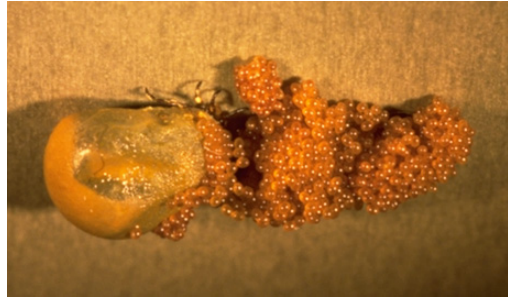


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Blacklegged ticks feed on a wide variety of mammals and birds, requiring 3-7 days to ingest the blood, depending on the stage of the tick. Larvae and nymphs of *I. scapularis* typically become infected with *B. burgdorferi* when they feed on a reservoir competent host. The white-footed mouse is the principal reservoir (source of infection) for *B. burgdorferi*, the protozoan agent of human babesiosis, *Babesia microti*, and can serve as a reservoir for the agent of human granulocytic ehrlichiosis. Birds are also a major host for immature *I. scapularis* and have been implicated in the long-distance dispersal of ticks and *B. burgdorferi*. White-tailed deer, *Odocoileus virginianus* (Zimmerman), are the principal host for the adult stage of the tick, which feeds on a variety of medium- to large-sized mammalian hosts. An engorged female tick may typically lay around 2,000 eggs or more.



Below clockwise from top left: Nymphal *I. scapularis* in the hand, close-up of an *I. scapularis* nymph (fingerlike projections of the tick mid-gut where the Lyme spirochetes are found are visible through the tick cuticle), female and nymph *I. scapularis* on finger, and nymphal *I. scapularis* on finger.



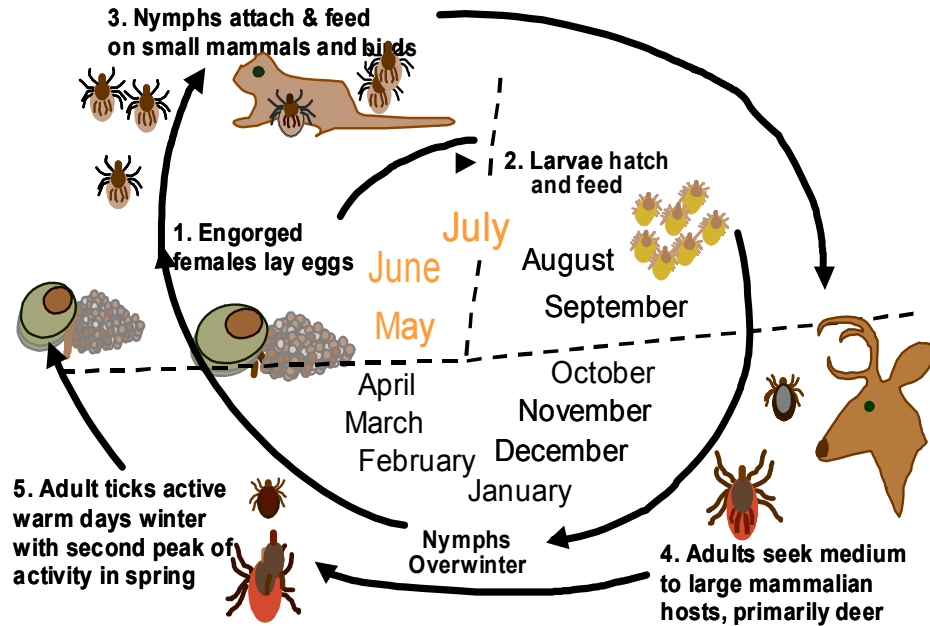
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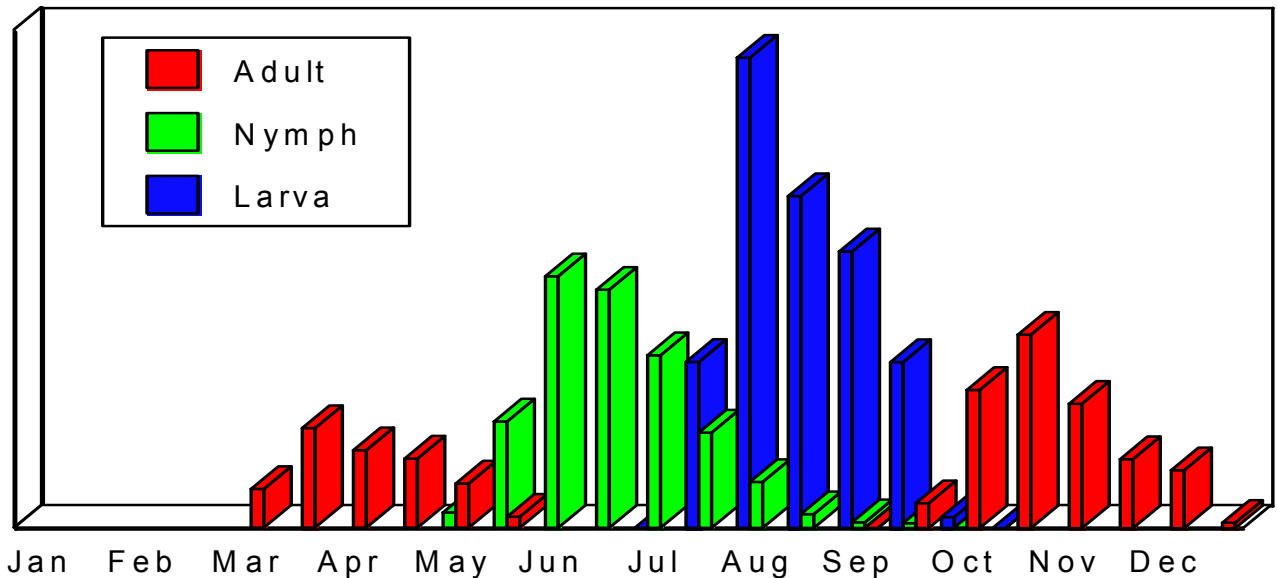
The Lyme disease spirochete in northern states is maintained, in part, by the two-year life cycle of the tick. Seasonally, the nymphs precede larvae and infect a new generation of animal hosts. Larvae

active later in the summer then become infected when feeding on reservoir host animals. Adults of *I. scapularis* are more commonly infected with *B. burgdorferi* than the nymphs because the tick has had two opportunities to become infected, once as a larva and once as a nymph.

Two-year Life Cycle for *Ixodes scapularis*.



Seasonal activity of *I. scapularis* adults, nymphs, and larvae.



The American Dog Tick, *Dermacentor variabilis* (Say)

The American dog tick, *Dermacentor variabilis*, is the primary vector of the causal agent of Rocky Mountain spotted fever in the eastern United States and is also a vector for the agent of tularemia. This tick does not transmit Lyme disease spirochetes and recent studies have indicated that it is not a vector for the agent of human granulocytic ehrlichiosis. The American dog tick, known by some people as the wood tick, is one of the most widely distributed and common ticks in the eastern and central United States, found from Nova Scotia to the Gulf Coast as far west as Texas, Kansas and the Dakotas. It is also found in parts of California, Oregon, eastern Washington, and northern Idaho. Only adults of the American dog tick feed on people and their pets – records of nymphs from humans are rare. The Rocky Mountain Wood tick, *Dermacentor andersoni*, is found in western North America from British Columbia and Saskatchewan south through North Dakota to northern New Mexico and Arizona and California. This tick is the vector for Rocky Mountain spotted fever and Colorado tick fever in western Canada and the northwestern United States.

Adult American dog ticks are reddish brown in color with silvery-gray or whitish markings on the back or upper body. They are almost 6.4 mm ($\frac{1}{4}$ inch) in length. The palps are short. The ornate markings are on the scutum of the female and on the male extend over the entire back. Female ticks increase dramatically in size as they obtain their blood meal from a host animal. Fully engorged females may reach $\frac{1}{2}$ inch in length (13 mm long by 10 mm wide) and resemble a dark pinto bean. Male ticks do not change notably in size as they feed. The scutum or plate does not change in size and the white markings are readily visible on a blood-fed tick. Adult dog ticks can be distinguished from adult *I. scapularis* by their larger size and the white markings on the dorsal scutum. In the northeast, adults of both tick species are active during the spring.

Dogs are the preferred hosts of adult ticks, but they also feed readily on other medium to large mammals. These include opossums, raccoons, skunks, fox, coyote, bobcat, squirrel, cattle, sheep, horses and people. Larvae and nymphs of the American dog tick feed on meadow voles (*Microtus pennsylvanicus*), white-footed mice (*Peromyscus leucopus*), and other rodents. In New Jersey, adult ticks are active from mid-March to mid-August. In Connecticut and Massachusetts, adults become active about mid-April to early May, peak in June, and may remain a nuisance until mid-August. Mating occurs on the host. A female tick will feed for 10-12 days. Once she is engorged with blood, she drops off the host, and may deposit about 3,000 to 7,000 eggs (average around 5,000). Males continue to ingest small amounts of blood from the host. In the northeast, the American dog tick probably requires 2 years to complete its life cycle as opposed to one year in the southern parts of its range. American dog ticks can live for extended periods without feeding, more than two years to almost three years, if suitable hosts are not available. Larvae, nymphs, and adults may live up to 540, 584, and 1,053 days, respectively, although typically survival will be much less.



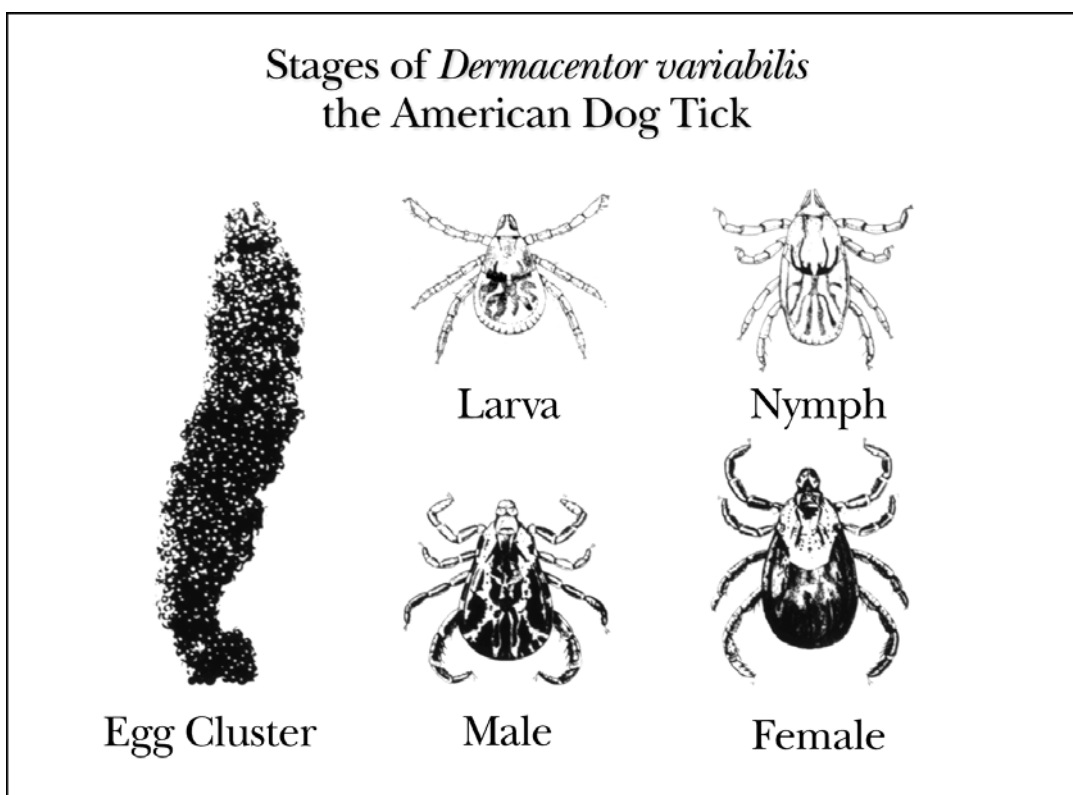
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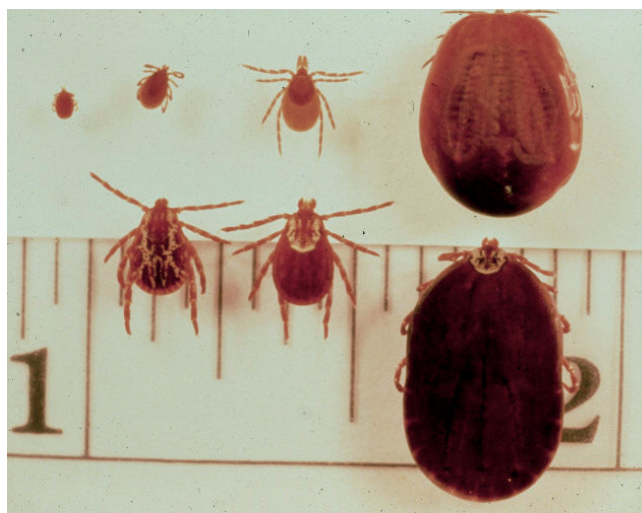


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American dog ticks are most numerous along roadsides, paths, old fields, marshy areas and trails in brushy woodlands or meadows with tall grass or weeds. Meadow voles are found in fields, pastures, fresh and saltwater marshes and meadows, borders of streams and lakes, and open and wooded swamps. Consequently, large numbers of American dog ticks may be encountered in these areas. People or their pets may bring these ticks from outdoors into the home, where they can survive for many days. However, the tick will not become established indoors. The Brown dog tick (page 13) is the species that may cause household infestations.



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Comparison between the blacklegged tick and American dog tick (above). Top row left to right: nymph, male, female, and engorged female *I. scapularis*. Note engorged female is nearly as large as the engorged female American dog tick. Bottom row left to right: male, female, and engorged female *D. variabilis*. Note the white markings on the scutum of *D. variabilis* can help distinguish between the two engorged ticks (ruler is marked in 1/16 inch intervals between the 1 and 2 inch mark).

The Lone Star Tick, *Amblyomma americanum* (L.)

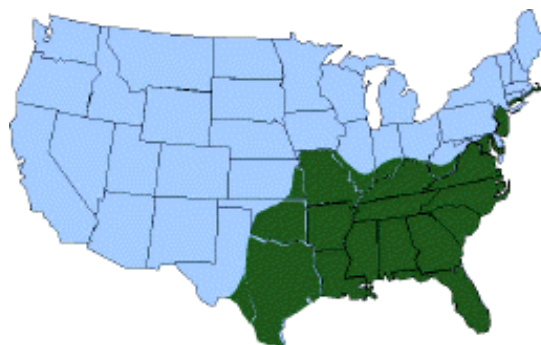
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The lone star tick, *Amblyomma americanum*, is named from the conspicuous spot on the end of the scutum of the female tick. This tick is the vector for *Ehrlichia chaffeensis*, the agent of human monocytic ehrlichiosis (HME). The tick does not transmit the Lyme disease bacterium, *B. burgdorferi*, but has been linked with a Lyme-like illness with a rash and other symptoms resembling Lyme disease called southern tick-associated rash illness or STARI. Possibly caused by another species of spirochete, attempts to culture the organism from skin biopsies at the rash or obtain serological evidence of Lyme disease from affected

patients have not been successful thus far. A new spirochete, *B. lonestari*, has been described from lone star ticks based on a DNA analysis and has recently been cultured from ticks. It has been detected in both a tick and associated rash, but it is yet not clear if it is the agent of the Lyme-like illness.

The lone star tick is widely distributed through the southeastern United States as far west as Texas and north to southern parts of Iowa, Illinois, Indiana, Ohio, and Pennsylvania. Along the Atlantic coast, its northern range extends to New Jersey and Long Island, New York, and it is also abundant on Prudence Island, Rhode Island. Lone star tick populations in Connecticut are sparse, but these ticks are occasionally recovered from residents, mainly in coastal communities in Fairfield and New Haven Counties.



Approximate distribution of *A. americanum* shown in green shaded area.

Lone star ticks are reddish brown in color and about 3 to 4 mm long. The palps of *Amblyomma* ticks are long. Female ticks have a conspicuous spot on the end of the scutum. Male ticks have faint white markings at the edge of the body. Nymphs are more circular in shape than *I. scapularis* nymphs and reddish in tint. Adults are active in the spring, while nymphs are active from April through the mid-summer. Larvae are active in the late summer and early fall.

The lone star tick has a wide host range, feeding on virtually any mammal. All stages will feed on people. On wild hosts, feeding occurs principally in and on the ears and the head. The bite of this tick can be painful because of the long mouthparts and attached ticks can cause great irritation. All stages are active during the summer months. Female ticks can deposit 1,000 to 8,000 eggs with an average of around 3,000 eggs. Deer and other large to medium sized animals are hosts for the adults and nymphs. Heavy infestations of this tick have been known to result in blindness and death of fawns of white-tailed deer. In some localities, this tick may also be known as the “deer” tick. Larvae and nymphs commonly feed on large and medium-sized mammalian hosts. Larval ticks also feed on many species of birds. Rodents do not appear to be important hosts for immature *A. americanum*.

Other Ticks

***Ixodes cookei* Packard**

Ixodes cookei, sometimes referred to as the “woodchuck tick”, is found throughout the eastern half of the United States and Canada. It is a primarily a parasite of medium-sized mammals such as woodchucks, opossums, raccoons, skunks, and foxes. In a New York study, it was the second most abundant tick on medium-sized mammals behind *I. scapularis*. All stages of *I. cookei* will feed on humans, though reports in southern New England and New York are uncommon. It appears to be a more frequent human parasite in northern New England and Ontario, Canada. After the American dog tick, *I. cookei* was the second most common tick removed from humans in Maine from 1989-1990 (*I. scapularis* was third). Lyme disease spirochetes have been detected in this tick, but laboratory studies suggest it is not a good vector for *B. burgdorferi*. However, *I. cookei* is the principal vector for Powassan virus, which can cause severe or fatal human encephalitis.

Brown Dog Tick, *Rhipicephalus sanguineus* (Latreille)

The brown dog tick or kennel tick, *Rhipicephalus sanguineus*, is a three-host tick found almost worldwide and throughout the United States. The tick is more abundant in the southern states. This is the only species of this genus in the U.S. Domestic dogs are the principal host for all three stages of the tick, especially in the United States, although the tick feeds on other hosts in other parts of the world. Adult ticks feed mainly inside the ears, head and neck, and between the toes, while the immature stages feed almost anywhere, including the neck, legs, chest, and belly. People may occasionally be attacked.

This tick is closely associated with yards, homes, kennels and small animal hospitals where dogs are present, particularly in pet bedding areas. In the North, this tick is found almost exclusively indoors. Brown dog ticks may be observed crawling around baseboards, up the walls or other vertical surfaces of infested homes seeking protected areas, such as cracks, crevices, spaces between walls or wallpaper, to molt or lay eggs. A female tick can deposit between 360 to 3,000 eggs. Under favorable conditions, the life cycle can be completed in about two months. This tick is the vector for canine ehrlichiosis (*Ehrlichia canis*) and canine babesiosis (*Babesia canis* or *Babesia gibsoni*). The brown dog tick is a vector for Boutonneuse fever in Europe and Africa.

Winter Tick, *Dermacentor albipictus* (Packard)

The winter tick, *Dermacentor albipictus*, is a one-host tick found commonly on moose (*Alces alces*), elk (*Cervus elaphus*), and deer. Hunters will encounter this tick (as well as *I. scapularis*) on harvested deer, moose, and elk during the hunting season. Heavy tick infestations can cause anemia and other problems and death of the animal. Larval ticks infest animals in the fall and then develop into nymphs and adults without leaving the host. Engorged females will drop off the host animal in the spring. This tick is broadly distributed from Canada to Central America. This tick will occasionally feed on humans.

Western Blacklegged Tick, *Ixodes pacificus* Cooley and Kohls

Although outside the scope of this handbook, readers should note that the western blacklegged tick, *Ixodes pacificus*, is the principal vector for Lyme disease to humans in the western United States. It looks just like the blacklegged tick in the east and only a specialist could tell them apart. It is found along the Pacific Coast in the western half of Washington and Oregon, almost all of California, and in parts of Utah, Arizona, and New Mexico. Infection rates with *B. burgdorferi* are generally low, 5-6% or less, because many of the immature *I. pacificus* ticks feed on the western fence lizard (*Sceloporus occidentalis*), a reservoir incompetent host for *B. burgdorferi* whose blood also contains a borreliacidal factor that destroys spirochetes in *I. pacificus* nymphs. Several rodents

(mainly woodrats) and a nest dwelling tick, *I. spinipalpis*, maintain the enzootic cycle of Lyme disease in California and other western states.

***Carios (Ornithodoros) kelleyi* Cooley and Kohls**

This tick feeds on bats and is found in homes, bat colonies, and other areas where bats may be found. It may occasionally bite humans whose dwellings are infested by bats. Distributed throughout the U.S., records from the northeast include Pennsylvania, New York, and Connecticut.



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Imported ticks

Travelers abroad have found exotic ticks on themselves after returning to the United States. Other ticks may be imported on pets and other animals. Some of these ticks are potential vectors of pathogens of domestic livestock and introduction and establishment of these ticks would have serious consequences for the livestock industry. For humans, there are a number of bacterial and rickettsial pathogens and encephalitis and hemorrhagic fever viruses carried by ticks in Europe, Asia, Africa and Australia. For example, cases of boutonneuse fever, also called Mediterranean spotted fever, have occurred in travelers returning to the U.S. Boutonneuse fever is distributed through Africa, countries around the Mediterranean, southern Europe, and India. Other spotted fever diseases are African tick-bite fever, Siberian tick typhus, and Queensland tick typhus.

Several tick-borne encephalitis viruses, as well as Lyme disease spirochetes, are transmitted by *Ixodes ricinus* ticks in the British Isles, central and Eastern Europe, and Russia and by *Ixodes persulcatus* from central Europe, Russia, parts of China, and Japan. The following ticks have been documented from traveler's returning to the northeast (destination, origin): *Amblyomma cajennense* (CT, Jamaica), *A. hebraeum* (CT, South Africa), *A. variegatum* (NY, Kenya), *Rhipicephalus simus* (CT, Kenya), *Dermacentor auratus* (ME, Nepal), and *Hyalomma marginatum* (CT, Greece). The Connecticut travelers returning from South Africa and Kenya were physician diagnosed with boutonneuse fever. Tick bite prevention measures should be taken by travelers to potentially tick infested areas abroad. Physicians should consider exotic tick-associated diseases in the differential diagnosis for a patient with a travel with a travel history outside the United States.



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Amblyomma hebraeum, one exotic species that has been imported into the U.S. Found throughout southern Africa, it is a vector for *Rickettsia conori*, the agent of boutonneuse fever. (J. Occi).

Louse Flies of Deer May Be Confused with Ticks

These flies are tick-like, blood-feeding parasitic flies (family Hippoboscidae), which may be confused with true ticks. The adult flies are dorsally flattened like a tick, with short legs. Several species are common parasites of white-tailed deer in the U.S. and are frequently seen by hunters or others in close association with deer. One species, *Lipoptena cervi* is known as the "deer ked" and was imported from Europe. It occasionally will bite humans. Other "deer keds" are native to the U.S. The female fly retains the larvae, nourishing them internally, and then lays mature larvae, which promptly pupate. The hippoboscids flies associated with deer have wings when they emerge, but lose them once they find a host.